

IAC-11-E6.1.2

ADVANCING INNOVATION THROUGH COLLABORATION: IMPLEMENTATION OF THE NASA
SPACE LIFE SCIENCES STRATEGY

Jeffrey R. Davis, MD

National Aeronautics and Space Administration (NASA)/Johnson Space Center, Houston, Texas, USA

jeffrey.r.davis@nasa.gov

Elizabeth E. Richard, MBA

Wyle Integrated Science and Engineering, Houston, Texas, USA

erichard@wylehou.com

On October 18, 2010, the NASA Human Health and Performance center (NHHPC) was opened to enable collaboration among government, academic and industry members. Membership rapidly grew to 90 members (<http://nhhpc.nasa.gov>) and members began identifying collaborative projects as detailed below. In addition, a first workshop in open collaboration and innovation was conducted on January 19, 2011 by the NHHPC resulting in additional challenges and projects for further development. This first workshop was a result of the SLSD successes in running open innovation challenges over the past two years. In 2008, the NASA Johnson Space Center, Space Life Sciences Directorate (SLSD) began pilot projects in open innovation (crowd sourcing) to determine if these new internet-based platforms could indeed find solutions to difficult technical problems. From 2008 to 2010, the SLSD issued 34 challenges, 14 externally and 20 internally. The 14 external challenges were conducted through three different vendors: InnoCentive, Yet2.com and TopCoder. The 20 internal challenges were conducted using the InnoCentive platform, customized to NASA use, and promoted as NASA@Work. The results from the 34 challenges involved not only technical solutions that were reported previously at the 61st IAC, but also the formation of new collaborative relationships. For example, the TopCoder pilot was expanded by the NASA Space Operations Mission Directorate to the NASA Tournament Lab in collaboration with Harvard Business School and TopCoder. Building on these initial successes, the NHHPC workshop in January of 2011, and ongoing NHHPC member discussions, several important collaborations have been developed:

- Space Act Agreement between NASA and GE for collaborative projects
- NASA and academia for a Visual Impairment / Intracranial Hypertension summit (February 2011)
- NASA and the DoD through the Defense Venture Catalyst Initiative (DeVenCI) for a technical needs workshop (June 2011)
- NASA and the San Diego Zoo for a joint challenge in biomimicry
- NASA and the FAA Center of Excellence for Commercial Space Flight for five collaborative projects
- NASA and ESA for a Space Medicine Workshop (July 2011)
- NASA and Tufts University for an education pilot
- Establishment of long-term contracts (August 2011) to enable future challenges
- Establishment of a new Center of Excellence for Collaborative Innovation (July 2011) for all federal agencies in the US

I. INTRODUCTION

After the initiation of the Constellation program in 2005, the life sciences research budget in NASA was reduced by forty-five percent. Given the reduction in resources, the Space Life Sciences Directorate (SLSD) at the NASA Johnson Space Center conducted a visioning exercise to determine a future scenario to increase the capabilities of the SLSD. The visioning exercise led to a determination that the SLSD should pursue alliances with external partners to augment internal capabilities and resources. A formal strategic plan was then developed utilizing all of the NASA and Wyle leadership team to develop goals and objectives spanning the subsequent 20-years to chart a future course for the SLSD. This strategic plan was published in May of 2007 and has undergone one update in 2009. The SLSD identified the following key vision and mission statements for the SLSD:

Vision statement: "To become the recognized world leader in human health, performance and productivity for space exploration".

Mission statement: "To optimize human health and productivity for space exploration".

The vision statement led to the development of the NASA Human Health and Performance Center (NHHPC) to serve as a convening and integrating organization for any organization interested in human health and performance issues. The mission statement led to the development of a risk management approach for the human system, and the identification of 65 human system risks, the mitigation of which is key to enabling successful long-duration human exploration. This paper will discuss the implementation of the strategic plan and several key results including the establishment of new convening centers specifically designed to facilitate collaboration among many diverse organizations.

II. RISK MANAGEMENT

The SLSD began to formulate an integrated risk management approach to human space flight in 2004 with the development of human space flight standards. These standards were needed to define appropriate parameters for mitigating high priority human system risks (such as bone loss, exposure to radiation, water quality, human factors etc). The standards were implemented in two volumes and both volumes were completed in 2010 after many development and approval sessions across the agency to get the best available evidence in support of the standards. These volumes are Space Flight Human System Standards (SFHSS) Volume I – Crew Health and SFHSS Volume II – Environment and Habitability.

The SFHSS provide the background to the formulation of the 65 human system risks to which research and technology development programs are applied to seek the best mitigation strategy for a given space light mission. The SFHSS also drive program requirements for the design of new human occupied spacecraft and habitats.

The 65 human system risks have been collected into one document and the evidence base to support each risk and mitigation approaches is being collected in a standardized format referred to as the Risk Mitigation Analysis Tool (RMATs). All 65 RMATs will be entered into a searchable database and managed by the SLSD through a Human System Risk Board (HSRB). The HSRB was initiated in April of 2008 and the membership spans the management team of the SLSD and the Human Research Program (HRP). The HSRB has the ability to determine the mitigation status of any risk, add or remove risks based on the best available scientific evidence, and recommend budget levels appropriate to address a particular risk.

The mitigation approaches to these 65 human system risks involves a portfolio of research and technology development work performed by NASA and work performed by external organizations through a variety of grant and contractual mechanisms. Given limited resources, any one risk may have one or more gaps in the ability to mitigate the risk from services to research to technology development. These gaps provided the opportunity to seek additional collaborations with external organizations and to pursue alliances and other relationships as identified in the 2007 SLSD Strategic Plan. The SLSD devised a benchmark effort to identify best practices in forming alliances.

III. BENCHMARK

In 2007, the SLSD began a two-year benchmark with approximately twenty external organizations in academia, industry and other government organizations. This benchmark was published in 2009 and several key findings guided SLSD pursuit of collaborative strategies and forming alliances. The benchmark found that both the technical and human resources aspects of alliances needed to be managed, and the SLSD established a Strategic Planning and Execution team with the Wyle Integrated Science and Engineering group. This group was charged to develop recommendations for establishing and managing alliances that led to the establishment of the NASA Human Health and Performance Center (NHHPC). The NHHPC was established in October 2010 to provide a convening and integrating forum for all members interested in human health and performance issues, to collect and disseminate best practices and to facilitate the development of collaborative projects among members. The NHHPC is discussed below in greater detail.

The benchmark also identified a 100% correlation between alliances and effective innovation among the organizations contacted for the benchmark. Organizations formed alliances to acquire novel ideas and approaches to problem solving, to acquire needed services, licenses or patents, and to further develop strategic plans.

In parallel with conducting the 2007-2009 benchmark, personnel in SLSD also sought training courses from the Harvard Business School, specifically Leading Change and Organizational Renewal, that provided new insights into open innovation (or crowd sourcing). Several business cases informed the SLSD of the value of using open innovation services, services to assist with building consortia, solve algorithms, and to pursue accelerated research

models that were focused on outcomes (such as the Myelin Repair Foundation in California). These additional learnings led to SLSD pursuing several pilot studies in collaborative innovation and those results are briefly discussed here. The interested reader can also find more detail about these pilot project results in a paper by Rando et.al. "xxxxxxx", October 2011, IAC meeting.

IV. COLLABORATIVE INNOVATION

In mid 2009, the SLSD pursued funding to conduct pilot projects in open innovation, running challenges to try to find technical solutions through an Internet based organization that posted challenges to a diverse and non-traditional group of NASA solvers. The SLSD was successful in obtaining sufficient funding and resources to pursue four pilot projects. These pilot projects included: InnoCentive – seven challenges were conducted using this open innovation platform. InnoCentive has a solver network of approximately 300,000 individuals. InnoCentive seeks solutions to challenges posed through a competitive prize mechanism; Yet2.com – six challenges were conducted with yet2.com that is a technology search firm that attempts to match organizations capable of solving a particular problem posed by the originating organization; TopCoder – one challenge was run with TopCoder to find an optimization algorithm for a lunar medical kit. This competition was sponsored by Harvard Business School (HBS) and NASA provided the challenge; NASA@Work – these challenges were run on the InnoCentive platform but conducted internally to NASA to seek solutions to problems across the agency. Twenty challenges were conducted in a very short period of time and were completed in 2010.

The results were spectacular. In the seven challenges run on the InnoCentive platform, the SLSD made full or partial awards for all seven challenges. One challenge was of special note that sought an algorithm to predict a solar proton event. Previous efforts had led to predictive capabilities of one to two hours; this challenge sought a predictive algorithm that could predict out to 4-24 hours, and 50% accuracy with a two-sigma confidence interval. The winning solution was accurate to 8 hours, at 85% accuracy, and a three-sigma confidence interval. Other challenges found a unique material (flexible graphite) to analyze for food packaging for very long duration space missions. The challenges that were posted on yet2.com also found interesting results. For imaging the architecture of bone in space, the challenge identified several new approaches in academia and industry that may be formed into a consortia to develop new technologies. The TopCoder challenge led to the acquisition of an open-source license for an algorithm that enhanced the effectiveness of a proposed lunar medical kit. This algorithm was incorporated into the existing Integrated Medical Model (IMM) and improved the design capabilities of this model for future medical kits. Finally, the NASA@Work challenges provided some very good technical solutions to the proposed challenges, and connected individuals across the agency that had not previously worked together. This latter aspect of NASA@Work indicates that the platform may be useful in assembling the best multi-disciplinary teams possible by identifying technical capabilities that can address technical issues around new or existing problems.

The SLSD also explored the use of new research model that promise accelerated results using non-traditional models. The Myelin Repair Foundation in California has developed an accelerated research model that connects several major research institutions, several disciplines of research, and has solved intellectual property and publication issues. This accelerated model has resulted in numerous patents in just a few years on the road to developing approaches to repairing the myelin sheath of nerves. The National Science Foundation explored using an accelerated model called IdeaLab and partnered with the UK research council to run a 5-day workshop in synthetic biology. This experiment yielded several funded proposals in a very brief period of time and engaged new researchers in these endeavours. The SLSD intends to deploy one or more of these research models in addition to the open innovation platforms cited above.

V. NASA HUMAN HEALTH AND PERFORMANCE CENTER

In October 2010, the SLSD realized one of the last components of the 2007 strategic plan by establishing the NASA Human Health and Performance Center (NHHPC). The NHHPC was established as a convening center to enable organizations from other government organizations, academia, industry and the non-profit sector to meet and exchange best practices around the themes of human health and performance. The outcomes envisioned from the NHHPC include collaborative projects among one or more members to leverage the resources of many diverse organizations, and to define problem statements that might explore different mechanisms of collaborative innovation (such as offering prizes) to solve the problem. The NHHPC envisioned partnerships between many different organizations and now has a robust membership of 90 organizations that include several NASA Centers,

JAXA, DLR, the FAA COE, two divisions of the NIH, and corporate partners such as GE, Philips, Nike, General Mills, PepsiCo and many others.

The NHHPC conducted its first workshop in January 2011 around the topic of collaborative innovation: strategies and best practices. The inaugural meeting was attended by over 120 individuals representing most of the current membership. Several initial projects were discussed and the breakout sessions led to the formation of “Member to Member Connect” presentations on a regular basis to keep the dialogue engaged between members. In August of 2011, a members only Wiki site was established to enable members to exchange best practices, needs and capabilities, and project and prize challenge ideas. The second workshop is scheduled for October 2011, and has a theme of STEM education and the value to any existing organization. Many opportunities for breakout sessions will be available to keep the many project discussions moving forward from the first workshop.

VI. CENTER OF EXCELLENCE FOR COLLABORATIVE INNOVATION

Realizing the results from the initial pilots in open innovation, the SLSD pursued established contracts that could be available for several years, so that these novel problem-solving mechanisms could be available for many other disciplines to utilize. The results from the pilots and the pursuit of these longer-term contracts, led the Office of Science and Technology Policy (OSTP) to request that NASA establish a Center of Excellence for Collaborative Innovation (COECI) for all federal agencies to share in best practices and results from conducting challenges and prizes across a wide range of disciplines to spur innovation. This new center will commence activities on October 1, 2001 and will be established at NASA HQ and at the Johnson Space Center, staffed by individuals from the SLSD. The COECI will engage several federal agencies each year through workshops aimed at results and best practices, training sessions to inform others how to identify, conduct and analyze challenges and prizes, and to share results. The goals of this center are to educate many others about the effectiveness of collaborative innovation in finding novel solutions to problems faced by an organization, and to assist in the establishment and conduct of effective challenges to spur innovation in the federal agencies. All federal agencies and disciplines are invited to be part of this new center. The center may later be expanded to include non-federal entities to take advantage of the America COMPETES act in fostering prizes between public and private organizations.

VII. HUMAN HEALTH AND PERFORMANCE PROGRAM OFFICE

The SLSD is pursuing one additional new organization to further implement its 2007 strategic plan and that is to integrate biomedical research and operations in a Human Health and Performance Program Office (HHPPO). This HHPPPO would combine the efforts and resources of Crew Health and Safety and the Human Research Program into a single management structure to provide for the most effective and efficient approach to mitigating the 65 human system risks for long duration space flight as articulated above. The HHPPPO would manage the 65 human system risks through a single board structure so that clinical, operational and research resources can be focused on existing and emerging risks, and address the many different flight environments for the future. The risk management approach to space flight can be customized to address suborbital, short suborbital, long duration orbital and finally planetary missions. This new program office is also envisioned to be in place by the fall of 2011 to complete the strategic planning process of SLSD and fully implement the human as a system within NASA for all future human missions.